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ABSTRACT

This guide is intended to provide an opportunity for students to work with weather symbols used for reporting weather. Also included are exercises in location of United States cities by latitude and longitude, measurement of distances in miles and kilometers, and prediction of weather associated with various types of weather fronts. (RE)

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Peter M. Metro, Director

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WEATHER & WEATHER MAPS

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March, 1977

TEACHER'S MANUAL

SE 029 539

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Gordon E. Rodeen, Ph.D.
Superintendent of Schools

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How to Use This Booklet

Weather and Weather Maps is designed to provide an opportunity for students to work with weather symbols used when reporting weather conditions in newspapers and on television. It is not a complete weather unit and must be supported by a more detailed study of weather. It does provide an opportunity for students to:

a) Locate cities within the United States by longitude and latitude.

b) Measure distances in miles and kilometers.

c) Predict weather associated with a cold front, warm front, occluded fronts and stationary fronts.

d) Work with common weather symbols.

A magnetic board visual aid system has been designed to support the activities in this booklet. A magnetic board and a set of magnetic illustrations are available in your school library.

WEATHER AND WEATHER MAPS

A Project ENRICH Publication

March, 1977

The air that blankets our planet Earth is an invisible, necessary, massive and restless ocean. We live at the bottom of this invisible ocean of air; without it, our Earth would be lifeless and sterile. There would be no trees, animals or birds. There would be no blue sky and no colored sunsets and sunrises.

At sea level, our blanket of air (atmosphere) exerts a normal pressure of 14.7 pounds on every square inch of surface. If the palm of your hand is twelve square inches in size, each time you lift your hand you are lifting over 176 pounds. If this is true, you are indeed a strong person. As you may have realized, this pressure is exerted on all sides of the hand so that there is a balance of pressure from all directions. The only significant resistance to lifting an open hand is that of gravity.

The first five miles of air above the earth is called the troposphere. It contains virtually all the water vapor that forms clouds. The next layer, the stratosphere is almost weatherless; this layer extends from five miles to to fifty miles above the earth's surface. Beyond the stratosphere is the ionosphere. It extends about 400 miles out into space.

It is in the troposphere where all the weather action occurs. This is the level where moisture condenses to form clouds and the unequal heating and cooling of the air results in updrafts, downdrafts and the breezes and winds we experience each day. It is this condensation of moisture and the movement of air that causes our weather.

Sailors, farmers, hunters, and fishermen study clouds, take note of the air's dampness on their cheeks, note the wind shift, observe the behavior of cattle and birds, remember sayings of past generations and, through experience, can come up with educated guesses as to what type weather might be expected.

The study of weather began as a myth. It was related to the mood of the gods. Today many people have their own sayings about the weather. These sayings are not based on myth; they have some degree of scientific merit even though they are based on individual observations. A few of these sayings are:

- "Mackerel sky, mackerel sky, never long wet, never long dry."
- "Mackerel sky and mare's tails make tall ships carry small sails."
- "Rain before seven, clear before eleven."
- "Red skies in the morning, sailors take warning. Red skies at night, sailor's delight."

As you study weather you will soon realize that these sayings are based on observations of cloud types that are associated with cold fronts and warm fronts.

Today man has developed more sophisticated ways of predicting the weather. He has developed instruments that measure air pressure (barometer), the amount of moisture in the air (hygrometer and psychrometer), wind velocity (anemometer), and instruments that record conditions high above the earth (radiosonde).

The information gathered by these instruments is compiled from weather stations throughout the country and used to assist in weather forecasting. Such forecasts are made by the U. S. Weather Bureau which was established in 1891.

In addition to weather forecasting, the U. S. Weather Bureau provides the following services:

1) Making weather maps
2) Making special forecasts for aviators

3) Sending warnings of storms, frosts and floods

4) Making special forecasts in connection with forest fires

5) Keeping records of the weather

6) Publishing crop reports

7) Studying the weather and publishing accounts of anything new that is discovered.

Reading a weather map and accurately predicting the weather requires a great deal of skill. A person who studies and interprets weather maps is called a meteorologist. We often watch local meteorologists on television as they present today's weather and "attempt" to accurately predict tomorrow's weather.

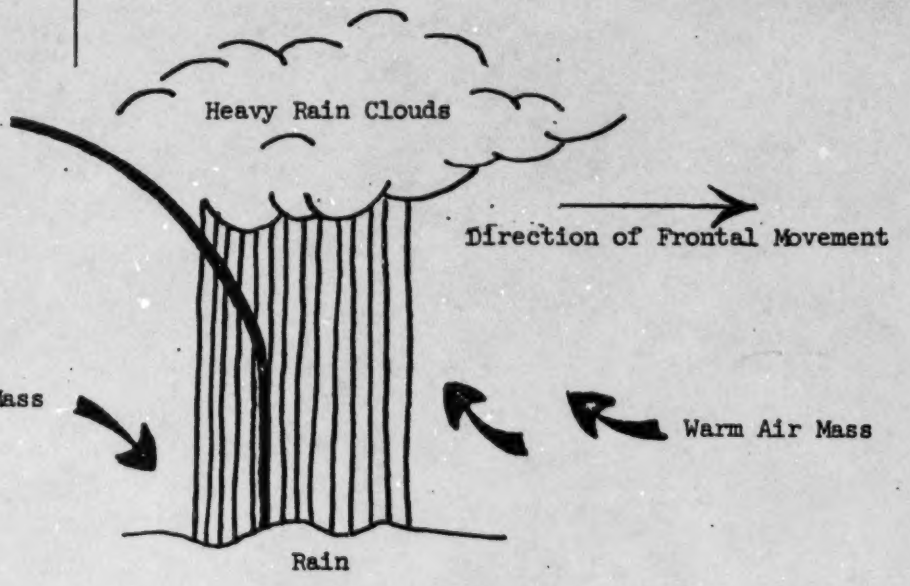
We will be using the "Weather Magnetic Board" to help us construct weather maps. But before we can do this, we must understand more about how to read and interpret weather information.

THE WEATHER MAP

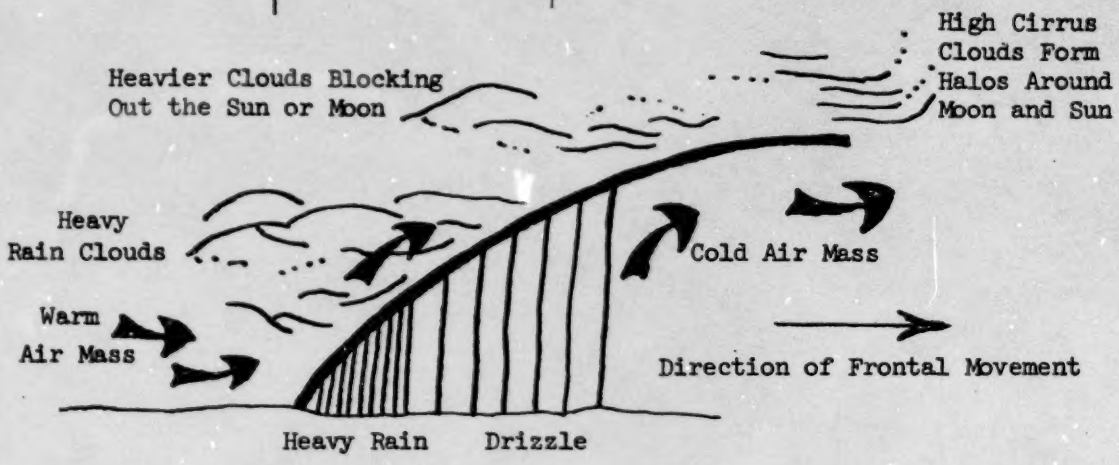
In order to read a weather map, one must understand the meaning of weather symbols. These symbols are the meteorologist's shorthand which permits him/her to put a great deal of information in a small space. You do not have to memorize the symbols given here, but you should be able to find what symbols to use when you are asked to construct a weather station report using the magnetic board. The symbols given are the type used by newspapers. You will find that actual weather maps contain much more information and therefore, use many more symbols at each reporting area.

I. WEATHER FRONTS

Weather Condition	Symbol	Important Information
A. Cold Front		1) A cold front is a boundary along which cold air moves under and into warm air.
		2) Cold fronts move faster than other fronts. 3) Thunderstorms are common along a cold front. 4) Rains along a cold front generally are heavy, but they do not last long. 5) When a cold front passes; - temperatures fall rapidly - the wind increases in velocity - the wind changes direction - it rains for a short time after the front passes and then it clears.



Weather Conditions	Symbols	Important Information
B. Warm Front		1) A warm front is a line along which warm air is pushing out colder air.



2) Cirrus clouds lead the high level of an advancing warm front. Behind these high clouds come the types of clouds that form halos around the moon. Such halos make it possible for a person to predict the weather twenty-four to thirty-six hours in advance.

3) Heavy high clouds follow the cirrus clouds and screen out the sun and the moon.

4) Heavy low clouds follow the high clouds and it generally starts to rain, snow, hail or sleet.

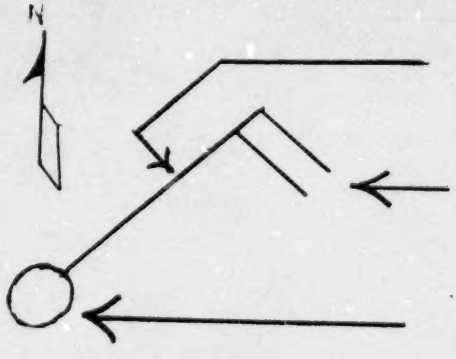
5) When the warm front passes, precipitation can fall for hundreds of miles causing a steady rain and gloomy weather for a long period of time.

6) As the front passes, the temperature rises, winds shift, the air pressure falls then rises again, the rain ends and the skies clear.

Weather Conditions	Symbols	Important Information
C. Stationary Front		1) A cold front or a warm front slows down until it stops moving. The air masses on both sides of a line are said to be separated by a stationary front. 2) Weather of a stationary front is about the same as the weather of a warm front. 3) When the front starts to move again, it becomes a cold front if the cold air advances and a warm front if the warm air advances.
D. Occluded Front		1) This is a combination of a cold and a warm front. It happens when a cold front overtakes a warm front. 2) When the warm air mass and cold air mass mix, the front breaks down. 3) It can take either the characteristics of a warm front or a cold front.

II. WIND SPEED AND SKY COVER

The following symbols are used to indicate the speed of which the wind is blowing and from which direction it is blowing.

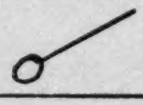
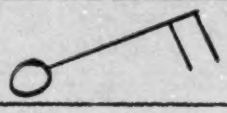
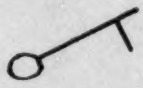
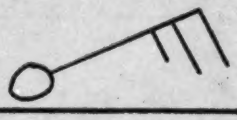
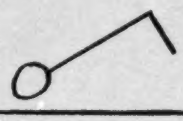
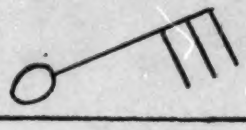


Direction from which the wind is blowing. (Northeast)

The flags indicate wind speed in miles per hour.

The circle is filled in to show how much of the sky is covered.

A. Wind Speed

Symbol	Miles Per Hour	Symbol	Miles Per Hour
	1 through 4		21 through 25
	5 through 8		26 through 31
	9 through 14		32 through 37
	15 through 20		38 through 43

B. Sky Cover

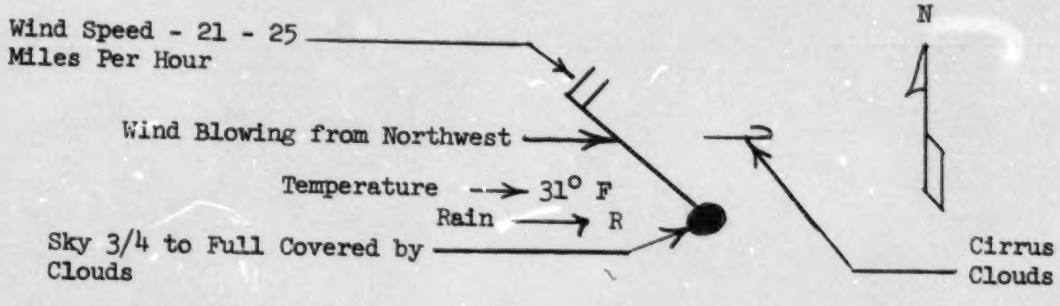
Symbol	Meaning
	Clear - no clouds - up to 1/4 of the sky covered.
	Sky 1/4 covered up to 3/4 covered by clouds.
	Sky 3/4 covered to fully covered by clouds.

III. Other Symbols (used by newspapers)

Symbol	Meaning
(R)	drizzle, rain, shower
(S)	snow, sleet
(F)	fog
——→	cirrus clouds
_ _ _	stratus clouds
⌒	cumulus clouds

IV. Trying Your Hand With Weather Symbols

There are many more symbols that are used when recording the weather at a weather station. However, for our purposes we will only use those given in this pamphlet. Below is a typical weather station with its symbols. Take note of where each type of symbol is located. (R) (S) and (F) always goes to the left of the circle indicating cloud cover. The temperature is directly above the (R) (S) or (F) and the type of cloud is always in the space marked cirrus clouds.



Let us now establish some weather stations. Each of the cities listed on the next page can be located by its longitude and latitude reading. Your teacher will help you locate each city, but you should practice finding them yourself. Remember that all latitude and longitude readings are for the northern hemisphere and western longitudes.

Each student should take turns locating a city and indicate the weather for that city by placing the correct magnetic symbols on the magnetic board. The latitude and longitude lines will help you determine direction.

Activity	City	Location	Weather Conditions
A	Cleveland, Ohio	42° N. Latitude 82° W. Longitude	•Clear sky •Wind from the northwest at 12 miles per hour •Temperature 59° F
B	Miami, Fla.	26° N. Latitude 81° W. Longitude	•Sky fully covered by clouds •Wind from south at 22 miles per hour •Stratus clouds •Rain •Temperature 77° F
C	San Francisco, California	37° N. Latitude 123° W. Longitude	•Less than 1/4 of the sky covered by clouds •Winds from west at 4 miles per hour •Cumulus clouds •Temperature 68° F
D	Portland, Maine	44° N. Latitude 69° W. Longitude	•Sky over 1/4 but less than 3/4 covered by clouds •Wind from northwest at 27 miles per hour •Cirrus clouds •Temperature 42° F

Activity	City	Location	Weather Conditions
E	Chicago, Illinois	42° N. Latitude 88° W. Longitude	•Sky over 1/4 but less than 3/4 covered by clouds •Wind from northwest at 12 miles per hour •Cirrus clouds •Temperature 56° F
F	Seattle, Washington	48° N. Latitude 122° W. Longitude	•Sky fully covered by clouds •Wind from north at 6 miles per hour •Stratus clouds •Temperature 42° F
G	Phoenix, Arizona	34° N. Latitude 113° W. Longitude	•Sky clear, less than 1/4 covered by clouds •Wind from southwest at 22 miles per hour •Cumulus clouds •No precipitation •Temperature 71° F
H	New Orleans, Louisiana	30° N. Latitude 90° W. Longitude	•Sky fully covered by clouds •Wind from southwest at 35 miles per hour •Stratus clouds •Rain •Temperature 73° F

Activity	City	Location	Weather Conditions
I	Raleigh, N. Carolina	36° N. Latitude 78° W. Longitude	Sky over 3/4 covered by clouds Wind from east at 18 miles per hour Cirrus clouds No precipitation Temperature 70° F
J	St. Louis, Missouri	39° N. Latitude 91° W. Longitude	Sky 1/2 covered by clouds Wind from northwest at 18 miles per hour Stratus clouds Drizzle Temperature 60° F
K	Denver, Colorado	39° N. Latitude 104° W. Longitude	Sky 7/8 covered by clouds Wind from north at 7 miles per hour Stratus clouds Snow Temperature 32° F
L	Duluth, Minnesota	47° N. Latitude 93° W. Longitude	Sky fully covered by clouds Wind from northeast at 16 miles per hour Stratus clouds Sleet Temperature 34° F

Activity	City	Location	Weather Conditions
M	Boise, Idaho	44° N. Latitude 115° W. Longitude	•Sky 3/8 covered by clouds •Wind from northwest at 20 miles per hour •Stratus clouds •Showers •Temperature 44° F
N	Great Falls, Montana	48° N. Latitude 111° W. Longitude	•Sky completely covered by clouds •Wind from north at 26 miles per hour •Stratus clouds •Snow •Temperature 30° F
O	Dallas, Texas	34° N. Latitude 105° W. Longitude	•Sky less than 1/2 covered by clouds •Wind from southwest at 3 miles per hour •Cumulus clouds •No precipitation •Temperature 68° F
P	New York City, New York	40° N. Latitude 75° W. Longitude	•Sky completely covered by clouds •Wind from the southeast at 3 miles per hour •Stratus clouds •Fog •Temperature 54° F

Turn your magnetic board around so that you cannot see the weather stations. Repeat the activity by locating the 16 cities on the map provided you by your teacher. Put in all of the weather symbols for as many cities as you can during your work period. When you feel that you have completed your work, check it with the magnetic board.

V. More Weather Map Activities

Magnetic Marker to Identify City

Activity

Q

Warm Front

1) Philadelphia, Pennsylvania is located at 40½° North latitude and 75° West longitude. Mark it with a magnetic marker.

2) Atlanta, Georgia is located at 34° North latitude and 84° West longitude. Mark it with a magnetic spot.

3) Connect Philadelphia and Atlanta with the magnetic symbol for a warm front. (Overlap the strips of warm front magnetic tape to keep from cutting it.)

4) Check the conditions caused by a warm front. These conditions are outlined in this pamphlet. Discuss and answer the following questions:

   a. If the front is moving east, what kind of clouds would you expect to see over Washington, D. C.?

   b. What type of clouds would you expect to find immediately east of the front?

   c. What kind of weather would you expect along the front?

   d. Does the weather along the warm front generally last a short time or do the conditions tend to last several days?

   e. As a warm front passes, does the air temperature rise or fall?

   f. How many miles long is this warm front? Kilometers?

R

Cold Front

1) Reno, Nevada is located 40° North latitude and 120° West longitude. Place a magnetic marker at the spot where Reno is located.

2) Fargo, North Dakota is located at 47° North latitude and 97° West longitude. Place a magnetic marker at the spot where Fargo is located.

Activity

R

Cold Front (cont.)

3) Connect Reno, Nevada and Fargo, North Dakota by the symbol for a cold front. Overlap the front symbol if the pieces are too long to keep from cutting.

4) Check the conditions caused by a cold front. Discuss and answer the following questions:

   a. If the front is moving east, what type of weather would you expect in Cheyenne, Wyoming as the front passes through?

   b. Which travels faster a cold front or a warm front?

   c. Would you expect thunderstorms along a cold front?

   d. Which type of front produces the heaviest rains; a warm front or a cold front?

   e. Which rains last the longest; rains caused by a cold front or rains caused by a warm front?

   f. When a cold front passes, does the air temperature rise or fall?

   g. As a cold front passes, how does the wind change?

   h. How many miles long is this cold front? Kilometers?

S

Stationary Front

1) Tampa, Florida is located at 28° North latitude and 83° West longitude. Place a magnetic marker on the location of that city.

2) Boston, Massachusetts is located at $42\frac{1}{2}^{\circ}$ North latitude and 71° West longitude. Place a magnetic marker on the location Boston.

3) A stationary front exists between these two cities. Place a stationary front marker between the two cities so that the warm front faces west.

4) Discuss the following questions:

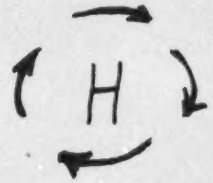
   a. Why do we call this front a stationary front?

   b. If the warm air started to move east, would it be a warm front or a cold front?

Activity		
S Stationary Front (cont.)	c.	Is the weather of a stationary front more like that of a cold front or that of a warm front?
	d.	How many miles long is this front? Kilometers?
T Occluded Front	1)	Detroit, Michigan is located at 43° North latitude and 83° West longitude. Place a magnetic marker at the location of Detroit.
	2)	San Antonio, Texas is located at 29° North latitude and 99° West longitude. Place a magnetic marker at the location of San Antonio.
	3)	Connect these two cities with an occluded front magnetic marker.
	a.	How is an occluded front formed?
	b.	What eventually happens to an occluded front?
	c.	Is the occluded front more like a warm front or a cold front?
	d.	How many miles long is the front? Kilometers?

VI. Highs and Lows

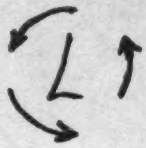
A high pressure area is a single air mass where the winds blow in a clockwise motion in the Northern Hemisphere (counter clockwise in the Southern Hemisphere).



Direction of wind in a Northern Hemisphere High Pressure Area.

Another name for a high pressure area is an anticyclone. Bright, clear weather is usually present throughout the anticyclone or high pressure area. Such an area may have a diameter of 1,000 miles.

A low pressure area (called cyclone) in the Northern Hemisphere has winds that move in a counterclockwise motion.



Direction of
Winds in a Low Pressure Area

In the Southern Hemisphere the winds would move in a clockwise motion. Almost all cyclones move toward the northeast. In the United States they form in the northwest, southwest and southeast and start this northeast movement. Their rate of motion is from 500 to 700 miles in one day.

Tropical lows (cyclones) are called hurricanes. They are large revolving storms that produce violent winds, heavy rains, and high waves. Hurricanes are given feminine names for identification purposes.

Tropical lows are also called typhoons when they originate in the China Sea or Pacific Ocean; they are called "Willy-willies" when they form near Australia. Whatever the name, tropical lows are respected by all who have experienced their power.

Activity
U
High and Lows

1) If there was a high pressure area over Detroit, Michigan;

   a. From what direction would the wind be blowing in Cleveland, Ohio?

   b. What kind of weather might we expect in Cleveland, Ohio?

2) If there was a low pressure area over Detroit, Michigan;

   a. From what direction would the wind be blowing in Cleveland, Ohio?

   b. What kind of weather might we expect in Cleveland, Ohio?

3) Check your answers for a and b by reconstructing a high and a low pressure area over Detroit, Michigan on the magnetic board. Use the arrows to indicate wind direction.

Activity		
U High and Lows (cont.)	4)	If there was a low over Detroit, Michigan during the winter, would you expect warmer or colder weather in Cleveland, Ohio? Give a reason for your answer.
	5)	If there was a high over Detroit, Michigan during the winter, would you expect colder or warmer weather in Cleveland, Ohio? Give a reason for your answer.
V Hurricanes and Typhoons	1)	Place the magnetic marker "Hurricane Betsy" on the magnetic board in an area where it might originate.
	2)	Where would you place the marker for a typhoon? (See page 19)

VII. Tornadoes

Tornadoes are the smallest, briefest yet most violent of all storms. They occur more frequently in the United States than in any other part of of the world. Most occur in the Mississippi Valley and in the eastern half of our Great Plains.

The path of a tornado is unpredictable. Its diameter averages about one-fourth of a mile but may be as wide as a mile. They travel about 25 to 40 miles an hour. You are seeing a small tornado when you see a "water spout" over Lake Erie.

It is not uncommon to have a television broadcast interrupted by an announcement that we are under a "tornado watch." This means that the area covered by the watch in which the chances of a tornado are high. If the announcement states that we are under a "tornado warning", this means that an actual tornado has been sighted.

The damage caused by tornadoes is partially due to high winds, but it is also due to the low air pressure it creates. When a tornado passes by a building which is tightly insulated and all windows and doors are closed, the pressure on the outside of the building becomes much lower than the air pressure within the building. Therefore, the structure

explodes in much the same way as an overinflated balloon bursts.

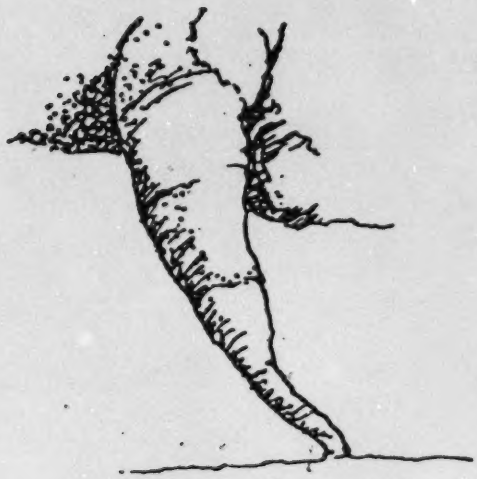
When there is danger of a tornado and a tornado warning has been issued, it is wise to open windows and doors and retreat to the basement for protection. Although the chances of a tornado striking your home is unlikely, listening to the radio or television weather warnings and following the broadcasted safety instructions is a wise practice.

Activity

W

Tornadoes

1. Place the tornado symbols on the magnetic board in the areas where they most often occur.
2. Place waterspouts on the board in areas where they might be seen.



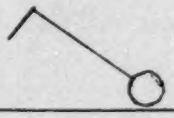
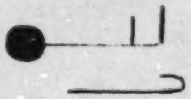
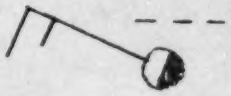
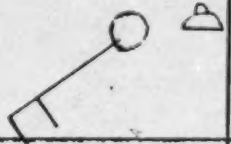
A Typical Tornado

Hurricane in the Southern Hemisphere
(Note the clockwise motion of air.)

Hurricane in the Northern Hemisphere
(Note the counterclockwise motion of air.)

ANSWER KEY TO ACTIVITY IV

TRYING YOUR HAND WITH WEATHER SYMBOLS

A. 15°C 59°F 	E. 13.3°C 56°F	I. 21.1°C 70°F 	M. 6.7°C 44°F (R)
B. 25°C 77°F (R)	F. 5.5°C 42°F	J. 15.6°C 60°F (R) 	N. -1.1°C 30°F (S)
C. 20°C 68°F	G. 17.8°C 71°F 	K. 0°C 32°F (S)	O. 20°C 68°F
D. 5.6°C 42°F	H. 22.8°C 73°F (R)	L. 1.1°C 34°F (S)	P. 12.2°C 54.4 F (F)

ANSWER KEY TO ACTIVITY V

MORE WEATHER MAP ACTIVITIES

Activity

Q - 4
a) Cirrus
b) Heavy clouds that block out the sun or moon
c) Rain and drizzle
d) Tends to last several days
e) Rises
f) Approximately 720 miles -- 1,159 kilometers

R - 4
a) Heavy rain
b) Cold front
c) Yes
d) Cold front
e) Warm front rains
f) Temperature falls
g) Yes
h) Approximately 1,200 miles -- 1,931 kilometers

S - 4
a) A cold front or a warm front slows down until it stops moving and becomes stationary
b) Warm front
c) Warm front
d) Approximately 1,350 miles - 2,173 kilometers

T - 3
a) It is formed when a cold front overtakes a warm front.
b) The warm air mass and the cold air mass mix and the front breaks down
c) It takes the characteristics of either a warm front or a cold front
d) Approximately 1,350 miles -- 2,173 kilometers

U - 1
a) North or northwest
b) Clear with cool air

U - 2
a) South or southwest
b) Cloudy, raining with warm air

U - 3
Answers not needed.

U - 4
Warmer - the winds would be coming from the warmer south.

U - 5
Colder - the winds would be coming from the colder north.

ANSWER KEY TO ACTIVITY V

MORE WEATHER MAP ACTIVITIES (cont.)

Activity	
V - 1	Place marker in the Caribbean area near Florida
V - 2	Place typhoon marker in the Pacific Ocean
W - 1	Place tornado markers in the eastern half of the Great Plains - Ohio, Indiana, Illinois, Mississippi, Nebraska, Kansas, etc.
W - 2	Place water spouts over Lake Erie and other Great Lakes

GLOSSARY

anemometer:	an instrument used to measure wind speed
atmosphere:	the envelope of air surrounding the Earth
cirrus clouds:	thin wispy clouds of ice crystals at high altitudes
cold front:	boundary formed when a mass of cold air displaces a mass of warm air
condenses:	the act of changing from water vapor to water droplets
downdraft:	a rapid moving of an air mass toward the Earth
drizzle:	a very light, misty rain
halo:	rings that appear to form around the sun or the moon when cirrus clouds are present
hygrometer:	an instrument used to measure the amount of moisture in the air
ionosphere:	the layer of the atmosphere that is the farthest from the Earth's surface
meteorologist:	a person trained in weather forecasting
precipitation:	moisture falling to the Earth in the form of rain, snow, sleet, hail or drizzle
psychrometer:	another type of instrument used to measure the amount of moisture in the air
radiosonde:	a balloon equipped with instruments that sends back to Earth the weather conditions in the upper atmosphere
resistance:	any type of action that prevents change
stratosphere:	the layer of the atmosphere that is between the layer nearest the Earth and the layer most distant from the Earth
troposphere:	the layer of the atmosphere nearest to the Earth's surface
updrafts:	a rapid movement of an air mass away from the Earth's surface
warm front:	boundary formed when a mass of warm air takes the place of a mass of cold air

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